(12) UK Patent Application (19) GB (11) 2 348 726 (13) A

(43) Date of A Publication 11.10.2000

(21) Application No 9907786.9

(22) Date of Filing 07.04.1999

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(51) INT CL^7
G08B 21/04

(52) UK CL (Edition R)
G4N NHSX

(56) Documents Cited
GB 2322464 A **GB 2192460 A** **GB 2103853 A**
WO 96/20449 A1 **US 4259548 A**

(58) Field of Search
UK CL (Edition Q) **G4N NHSX**
INT CL^6 **G08B 21/00**
ONLINE: EPODOC

(54) Abstract Title
Monitoring elderly people

(57) Intelligent furniture which is comprised in part by a set of sensors B, C, D, E and an intelligent processor (F Fig 2) in which a discriminator rejects data from the sensors below a pre-set limit. The sensor data is used to deduce the usage patterns and interaction of an individual with the furniture. A decision processor within (F) then uses sensor data to determine if a situation exists which warrants an alarm or a response, and if so determines what level of alarm or response is the most appropriate. Once initiated a alarm-initiated warning signal is triggered for a period of time t_a, and during this time the alarm can be cancelled manually. Alternatively (F) can transmit the sensor data or alarm to a remote receiver (G) for recording, processing or forwarding.

Items of intelligent furniture might include beds, chairs, chests of drawers, cupboards, and waste bins as well as electrical goods such as refrigerators, cookers, microwave ovens and washing machines. The presence of a decision processor in addition to sensing elements enables them to become "smart" sensors which can be used as the inputs to existing community alarm systems. They may also be used with advanced telecare systems to predict and detect future social or medical emergencies.

Figure 1

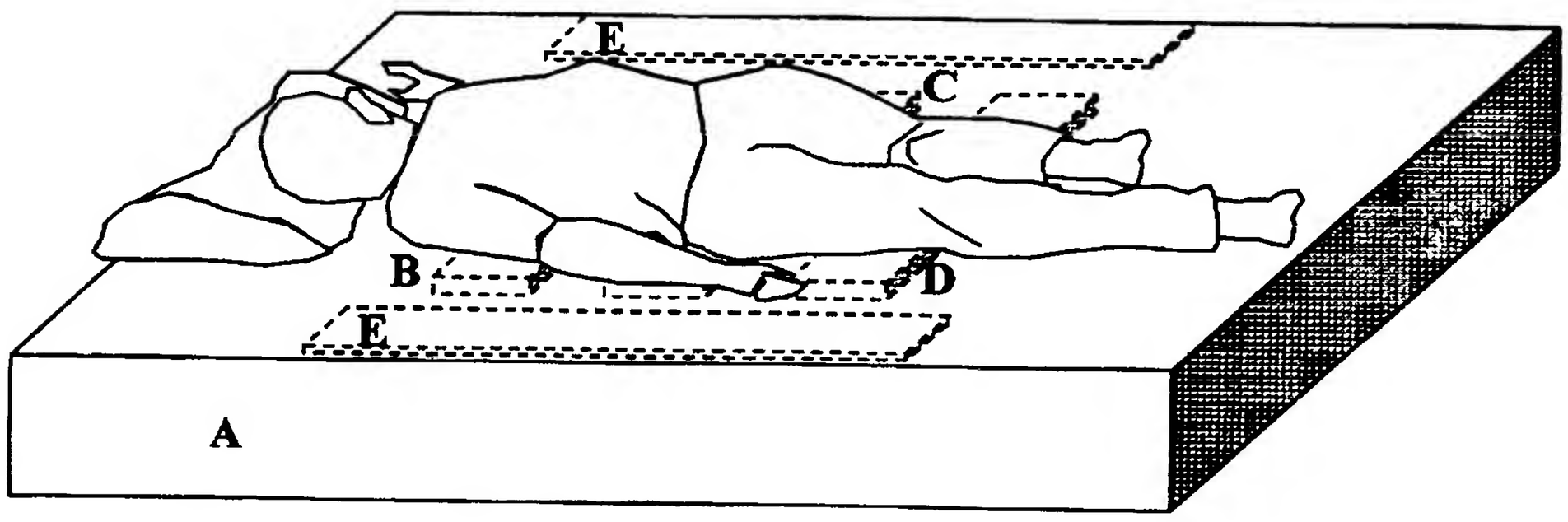

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Figure 1

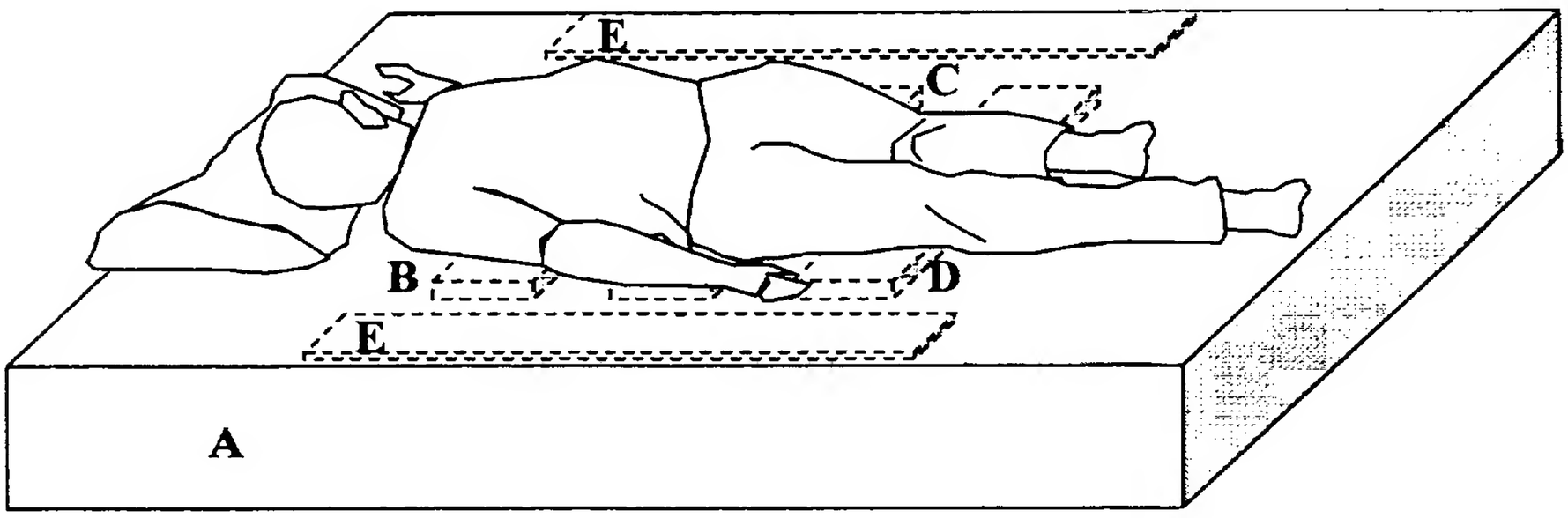
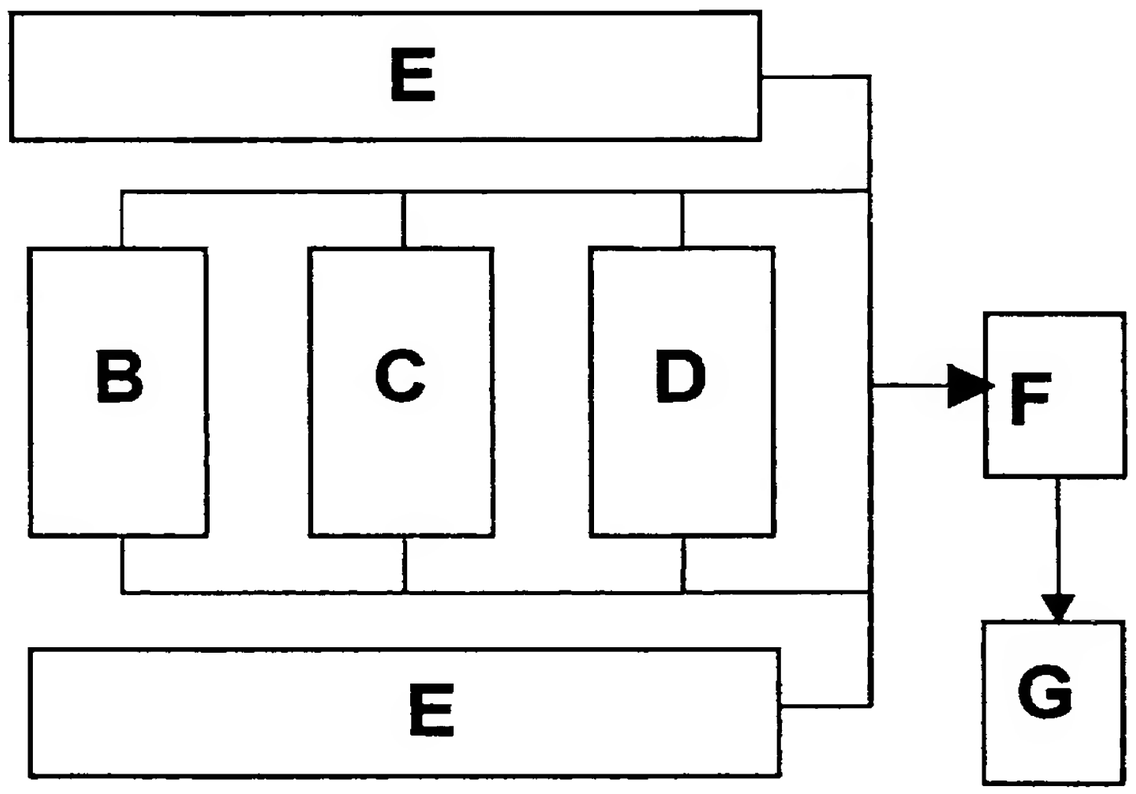


Figure 2



INTELLIGENT FURNITURE

Background to the Invention

People in the developed world are becoming progressively older as a result of improvements in housing, diet and healthcare. However, as they grow older they become more frail and likely to suffer from sudden illness or injury. In the past, such people were sent to long-stay institutions such as residential homes and geriatric hospitals for the final years of their lives so that enabling effective risk management.

The development of Community Care in the United Kingdom has sought to keep people in their own homes longer, usually supported by a range of care services as appropriate. Indeed, as most older people suffer from some chronic ailments such as poor circulation or rheumatoid arthritis they are not acutely ill and, indeed, the symptoms (and often the ailments) are controlled by various medication therapies. Thus, they are in a para-stable state – but likely to become seriously ill in the event of accident or infection.

Telecare technologies are capable of supporting these individuals both by providing access to an emergency response network through a personal alarm telephone (1st. generation telecare) or by automatically detecting certain emergency situations through the use of smart sensors (extended first generation telecare). Indeed, by including a combination of sensors and a local intelligence unit in the home, illness or accident may be predicted and detected (second generation telecare).

The range of sensors that may be required for use in a telecare system have been discussed in a number of publications (see for example, Doughty, Cameron and Garner "Three Generations of Telecare of the Elderly"; Journal of Telemedicine and Telecare, Vol. 2, No. 2, pp. 71-80 (1996)). Although simple sensors may suffice for basic systems, their lack of intelligence encourages ambiguous conclusions, the need for extended data transmissions and, ultimately, false-alarms. These problems can be overcome through the use of dedicated smart activity and usage sensors. They may be considered to be too intrusive if they need to be warn or if they are additional items of hardware that must occupy positions of prominence in the home.

The current invention overcomes these problems by integrating the sensors into the fabric of the home and, specifically, into the furniture that is likely to be present.

Description of the Invention

The present invention relates to methods and arrangements for intelligent furniture, which, in particular, but not exclusively can detect usage patterns, occupancy, movement modes, and changes in some physical parameter, and then can use this data to determine the appropriate response in a care situation. Hence, it can summon the appropriate level of assistance for the person, who may be incapable of summoning such assistance for themselves, or who may be unaware of the nature of a developing problem. Thus, it may become part of a prediction and prevention scheme.

By way of example, in a situation where a person lives or sleeps alone, the occupancy of a bed or chair, could be an indicating factor of their well being; a lack of use, or a severe reduction in use, could be employed to automatically summon help as and when appropriate.

Many manually operated personal emergency alarm or response systems already exist and these may take many different forms, including cord-operated alarms and push-button radio based alarms worn by the person. These have been found to be effective in a number of different ways. By way of example, by giving the users, who generally are elderly people living on their own in their own homes or in sheltered accommodation, a greater sense of independence and security (Hyer K., Rudick L., "The Effectiveness of Personal Emergency Response Systems in Meeting the Safety Monitoring Needs of Home Care Client" , J. Nursing Administration, Vol. 24, No 6, June 1994). Or, by way of example, by reducing the costs of hospitalisation and institutionalisation (Sherwood S., Morris J., "A Study of the Effects of an Emergency Alarm and Response System for the Aged", A Final Report, Boston MA, Hebrew Rehabilitation Centre for the Aged, 1981).

The present invention relates to a system which extends these and introduces further benefits, by providing an automatic system which does nor require any intervention by the user and, being intelligent, can detect conditions with complex variables in both behavioural patterns and time. It can be used either together with, or separate from, a manually operated system or as part of an integrated home care system.

The effectiveness, usability and acceptability of such devices are dependent upon a number of features that the present invention incorporates. The present invention relates to a means of detecting if a piece of furniture is being used, a means of determining the

mode of its use, a means of measuring the interaction of the user with the furniture, a means to count the number and/or frequency of usage events, a means to discriminate against false triggers, a means of initiation of an alarm determined by a decision process, a means for determining the most appropriate level for the alarm, a means of warning a person that an alarm is about to be sent, a means for switching off the alarm prior to it being sent, a means to transmit to a remote receiver, a means to process the alarm and/or mode event data, a means to store this data, a means to transmit this data or any derived data.

According to the present invention there is provided methods and arrangements for intelligent furniture. This comprises a sensor unit which may be embedded in some non-intrusive contained such as a pad which is then incorporated into the item of furniture. This could for example be a sensor unit associated with the mattress of a bed, the seat of a chair or the drawers of a cabinet. This sensor (which could be for example a single (or group of) strain gauges, or load cells in various combinations, or impact or vibration detector, or simple pressure-activated switches) is designed to monitor interactions of the person with the item of furniture.

By way of example it could monitor the person getting into and out of a bed, sitting on the edge of the bed, movements when in the bed, breathing, coughing, fever, etc. The output from this electronic circuit (or circuits) is related to the magnitude of the interaction, and directional information can also be determined if required. The electrical output it passed through a discriminator which enables, by way of example, small movements below a threshold (T_a) to be rejected. Data about the number, frequency and magnitude of all interactions between the person and the item of furniture above the minimum threshold (T_a) can be stored, processed and transmitted, as required. The discriminator setting also enables the interaction threshold of the sensor to be customised to accommodate for variables in both the user and/or their environment. By way of example it could be adjusted to compensate for variations in the user's original body mass. The intelligent processor enables false triggers generated, by way of example, by pets climbing onto the furniture to be discounted.

The item of furniture might similarly be devices used in maintaining the hygiene of the living environment. These might be the waste bin or the kitchen sink but might also be items of an electrical nature such as a washing machine, dish-washer, tumble drier or vacuum cleaner. Similarly, the use of other electrical appliances such as a refrigerator, a

microwave oven, a kettle and a cooker may be used to determine a person's lifestyle. In these cases, sensors may directly measure electrical activity or they may respond to light admitted to or emanating from the devices when the door is opened. Using information from all or any of the sensors mentioned above, either separately or combined with elapsed time, or with the previous history of response, conclusions about the effects of the person's interaction with the item of furniture can be deduced.

By way of example, if the sensors indicate that the user has got into bed, and then that they remain in bed beyond a pre-defined length of time, then there is a high probability that they are seriously ill. Hence an urgent alarm could be sent. If on the other hand the sensor determines, that over a period of time, the person's usage patterns of bed occupancy vary beyond a pre-determined threshold then it can alert a carer to visit to give the appropriate level of support. By way of example these functions and decision processing can be accomplished by the use a single chip processor.

The present invention also includes means to reduce the number of unwanted or false alarms. By way of example, the present invention can included a system which warns the user that an alarm has been initiated and that it is about to be transmitted, thus they have the option of cancelling the alarm. By way of example, a tone from the sensor unit indicates that after a set-time (t_a) the alarm will be transmitted, if the user feels that such an alarm is now inappropriate, they can cancel the alarm using a re-set switch. The alarm can either be generated by a local unit or by a remote unit. In the later case, the alarm signal or the sensor data, or a combination of these, are sent to a remote receiver. By way of example this could be by the use of an encoded radio signal based on the licence exempt MPT 1340 radio spectrum. The number of times that alarm signals are transmitted can be stored, processed or re-transmitted.

A specific embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows an example of the methods and arrangements for the sensor units for an intelligent furniture as a bed.

Figure 2 shows a block diagram of the circuit functions for an intelligent furniture unit as a bed.

Referring to the drawings, Figure 1 shows the methods and arrangements for an intelligent furniture unit as a bed, where **A** is the bed, **B** is a sensor positioned at or near to the chest position of a person lying on the bed, **C** is a sensor positioned at or near to the pelvic position, **D** is a sensor positioned at or near to the knee position. Sensors **E** are positioned near the edge of the bed.

Figure 2 shows a block diagram of the circuit functions of the arrangements for an intelligent furniture unit as a bed. If a person sits on the edge of the bed they are detected by sensors **E**. If a person gets into the bed and lies down, two or more of sensors **B**, **C**, and **D**, are provide the detection function. Sitting-up in bed is detected by sensors **C**, and **D**.

By way of example, consider if a person is about to leave their bed. First they may become restless, which is detected by a combination of sensors **B**, **C**, **D** and **E**. Then they sit-up which is detected by sensors **B** and **C**. They then sit on the edge of the bed which is detected by sensor **E**, before finally standing up which can be deduced from the combined sensor data.

The number, frequency, magnitude and direction, in combination, of the data from the sensors above a minimum threshold (T_a), is stored, processed, or transmitted using **F**. By way of example, if it is inappropriate for the person to get out of bed unaided then unit **F** can send an alarm to summon assistance at the most appropriate stage. By way of example, if the person lives alone, then it may be more appropriate for unit **F** to send a signal which automatically switches on the room lights. However, if more appropriate, all the relevant data can be sent to the remote receiver **G** which can carry out all or some of the data storing, processing, or transmitting functions.

As a safeguard, to reduce false alarms or inappropriate interventions, an audible, visible or other form of alarm can be initiated so that the person has the option of switching-off the alarm prior to it being transmitted by either units **F** or **G**.

The example described above shows how a particular sequence of activities over a short period of time may be employed to both identify an action (such as getting out of bed) and to confirm that a person is able to perform these actions within a reasonable period of time. Their independence in performing these actions can be determined by confirming that they are alone in the house through the use of other sensors such as

intruder alarm elements including passive infra red sensors, pressure mats and ultrasonic and microwave movement sensors. Changes of usage and ability may provide an indication of decline or recovery following accident or illness over an extended period of time. However, if one or more of the sensors on a particular item of furniture provide information on the actual level of interaction between the person and the furniture then the possibility of the direct long-term measurement of some parameter becomes practical.

By way of an example, consider a sensor placed on the seat of an armchair. This might be some piezoelectric or capacitative sensor as described above but it might also be an air-pressure sensor connected to the valve of an air-filled ring as used to provide limited pressure-relief for people who are likely to remain seated in a chair over extended periods of time. In its simplest form, this sensor may be employed to provide information on chair occupancy. However, it follows that the interaction between the person and the chair is primarily a function of the person's weight. Thus, this arrangement will be capable of making long-term assessments of the person's weight changes. This could be performed by the sensor itself providing that it had its own clock, calendar, memory facility and intelligent processor. Such an arrangement would allow sudden deviations from an average to be considered as the actions of a pet or child and eliminated automatically. It could also be programmed to seek long-term changes from the initial condition that would be considered to be dangerous. For example, it may be programmed to compare weight measurement with the measurement 4 weeks previously in the knowledge that changes in body weight of 10% over a period of one month or less are indicators of a serious lack of nutrition or of an adverse reaction to some medication.

In the above example, a change of weight of more than a specified amount over a certain period may be used to provide an alarm signal which may be transmitted to carer perhaps using a community alarm system. This would provide the relevant authorities such as social services or a community health trust with advanced warning of a problem which would enable them to intervene as appropriate. If there was no local processing in the sensor then there would need to be a method of communicating the measured data to a central processing unit on an intermittent basis. This might be achieved using a hard-wired link or by some wireless link using appropriate digital or analogue telemetry.

A high percentage of older people are likely to develop confusion or dementias either as a result of chronic ailments such as diabetes or as degenerative age-related diseases such as Alzheimer's disease. The symptoms include loss of cognitive function usually beginning with forgetfulness. Individuals may not appreciate their problems until they are assessed formally. Behavioural changes may be detected and assessed automatically using intelligent furniture such as a chest of drawers which may measure the rummaging which may be characteristic of the early stages of dementia. Intelligent furniture might similarly be employed to determine when such equipment or items are being used and to assess whether the use is consistent with usual behaviour. In particular, sufferers of dementia have little appreciation of time and may perform tasks such as household cleaning in the middle of the night.

In the same way, the attention of dementias sufferers to personal hygiene may be become compromised. Intelligent furniture such as washing machines, baths, showers and wash-hand basins may be used to determine the levels of hygiene being achieved and, especially, of changes with time, which may be consistent with a decline in cognitive function.

Fortunately, a number of new drugs are now being produced which may be successful in controlling dementia or, at least, in retarding its development. Proving the effectiveness of such treatments may be difficult because of the subjective nature of many assessments and the poor sensitivity to change of recognised methods such as the Abbreviated Mental Test. The use of intelligent furniture as part of an intelligent telecare system may allow such assessments to be made objectively and automatically on a continuous basis thus enabling not only the decline or otherwise of an individual to be monitored but also additional support services to be introduced as the need arises. The system may thus become cost-effective in providing only the level of service that is appropriate to the needs of the individual at any time.

CLAIMS

1 Intelligent furniture which comprises:
a means of detecting if a piece of furniture is being used by a person,
a means of determining the mode of its use,
a means of measuring it interaction with the person,
a means to count the number and/or frequency of usage events,
a means to discriminate against false triggers,
a means of making a decision based on measured data and programmed parameters,
a means of initiation of an alarm determined by a decision process,
a means for determining the most appropriate level for the alarm,
a means of warning a person that an alarm is about to be sent,
a means for switching off the alarm prior to it being sent,
a means to transmit to a remote receiver,
a means to process the alarm and/or mode event data,
a means to store this data, a means to transmit this data or any derived data.

2 Intelligent furniture as described in Claim 1 wherein the means of detecting its usage mode is determined by sensors that register an applied acceleration, force, pressure or impact.

3 Intelligent furniture as described in Claim 1 wherein the means of detecting its usage mode is determined by sensors that detect the close proximity of a person through changes in inductance, capacitance, change in light level or temperature.

4 Intelligent furniture as described in Claim 1 wherein the means of detecting its usage mode is determined by sensors which measures the magnitude of an applied acceleration, force, pressure or impact.

5 Intelligent furniture as described in Claim 1 wherein the means of detecting its usage mode is determined by sensors which measures the direction of an applied acceleration, force, pressure or impact.

6 Intelligent furniture as described in Claim 1 wherein the means of discriminating against false triggers is determined by a discriminator circuit.

7 Intelligent furniture as described in Claim 1 wherein the means of customising for user and/or environmental variables is determined by a discriminator unit.

8 Intelligent furniture as described in Claim 1 where the initiation of an alarm or response is determined by a decision process.

9 Intelligent furniture as described in Claim 1 where the initiation of an alarm or response is determined by a decision process based upon inputs from one or more sensor variables.

10 Intelligent furniture as described in Claim 1 where the initiation of an alarm or response is determined by a decision process based upon inputs from one or more sensor variables together with timing and sequence information.

11 Intelligent furniture as described in Claim 1 wherein the priority level of an alarm or response is determined by a decision process.

12 Intelligent furniture as described in Claim 1 where the priority level of an alarm or response is determined by a decision process based upon inputs from one or more sensor variables together with timing information

13 Intelligent furniture as described in Claim 1 where the incidence of false alarms are reduced by the use of an alarm-initiated signal prior to the alarm being sent.

14 Intelligent furniture as described in Claim 1 where the incidence of false alarms are reduced by the use of an alarm-initiated signal prior to the alarm being sent which can be acoustic, vibrational or optical in nature.

15 Intelligent furniture as described in Claim 1 where the incidence of false alarms are reduced by the use of a re-set switch.

16 Intelligent furniture as described in Claim 1 where the incidence of false alarms are reduced by the use a re-set switch by which the user can manually cancel the alarm before it is sent.

17 Intelligent furniture as described in Claim 1 where the appropriate alarm or response is sent to a remote receiver.

18 Intelligent furniture as described in Claim 1 where the appropriate alarm or response is sent to a remote receiver using a wireless system.

19 Intelligent furniture as described in Claim 1 where the appropriate alarm or response is sent to a remote receiver using a wireless system which could use inductive or magnetic coupling, radio, optical or acoustic transmission, or by transmission using other parts of the electro-magnetic spectrum.

20 Intelligent furniture as described in Claim 1 where data from the sensors can be stored and/or processed, and this or the derived data, transmitted or re-transmitted.

21 Intelligent furniture as described in Claim 1 where from the sensors can be stored and/or processed, and this or the derived data, transmitted or re-transmitted, in real time, on request, as a triggered response, or at time intervals.

22 Intelligent furniture as described in Claim 1 where data on the number and frequency of alarms or responses can be stored and/or processed, and this or the derived data, transmitted or re-transmitted.

23 Intelligent furniture as described in Claim 1 where data on the number and frequency of alarms or responses can be stored and/or processed, and this or the derived data, transmitted or re-transmitted, in real time, on request, as a triggered response, or at time intervals.

24 Intelligent furniture as described in Claim 1 which is compatible with a community alarm or social alarm system.

25 Intelligent furniture as described in Claim 1 which is compatible with a warden-call system as used in sheltered housing.

26 Intelligent furniture as described in Claim 1 which is the basis of a smart sensor.

27 Intelligent furniture as described in Claim 1 which is compatible with an extended first generation telecare system.

28 Intelligent furniture as described in Claim 1 which is compatible with a second generation telecare system.

29 Intelligent furniture as described in Claim 1 which may be used to monitor the Activities of Daily Living of an individual.

30 Intelligent furniture as described in Claim 1 which may be used to assess the cognitive function of an individual.

31 Intelligent furniture as described in Claim 1 which may be used to detect when an individual is unable to perform certain tasks.

32 Intelligent furniture as described in Claim 1 which may detect when an individual has slept overnight in a chair.

33 Intelligent furniture as described in Claim 1 which may detect that an individual has been unable to get out of bed unaided.

34 Intelligent furniture as described in Claim 1 which may detect restless sleep.

35 Intelligent furniture as described in Claim 1 which may detect sudden weight loss.

36 Intelligent furniture as described in Claim 1 which may indicate a lack of nutrition.

37 Intelligent furniture as described in Claim 1 which may indicate an adverse drug reaction.

38 Intelligent furniture as described in Claim 1 which may detect rummaging behaviour.

39 Intelligent furniture as described in previous claims where the item of furniture might be a waste-bin.

The Patent Office

INVESTOR IN PEOPLE

Application No:	GB 9907786.9	**Examiner:**	David Summerhayes
Claims searched:	1-39	**Date of search:**	20 July 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G4N (NHSX)

Int Cl (Ed.6): G08B 21/00

Other: Online: EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2322464 A	(LUNAN)	1 at least
X	GB 2192460 A	(MILLNS)	"
X	GB 2103853 A	(STRATHCLYDE)	"
X	WO 96/20449 A1	(GEROTECH)	"
X	US 4259548	(FAHEY)	"

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.